nature neuroscience

Separating science from stereotype

Harvard University president Lawrence Summers stirred up a hornet's nest in January when he suggested that innate biological differences may help explain why men have more career success in science and mathematics than women. His speech at a National Bureau of Economics conference, which was off the record, set off a storm of protest, and Summers has spent the last several weeks clarifying and apologizing for his remarks. Journalists have had a field day debating the incident, and although some have criticized Summers as being almost neanderthal in his thinking, others have portrayed him as a victim of political correctness.

There is no doubt that Summers' comments were impolitic. There is no official record of what he said, but his reported implication that men are biologically predisposed to outperform women at the upper end of the math and science spectrum has captured the media's fancy. Unfortunately, however, most of his supporters have not been preoccupied with evaluating whether this argument has any scientific merit. Are there neurobiological differences between men and women that may explain the gender gap in science and mathematics? The evidence to support this hypothesis of 'innate difference' turns out to be quite slim.

In his talk, Summers apparently cited a gender difference in Scholastic Aptitude Test (SAT) mathematics scores: boys are more likely than girls to score on the tail ends of the bell curve. (That is, the worst performers and the highest scorers tend to be male.) Similarly, in a 2003 study of teenagers by the Programme for International Student Assessment, boys outperformed girls in math by a statistically small margin (http://www.pisa.oecd.org/dataoecd/1/63/34002454.pdf). However, in 7 of 43 countries, boys and girls had similar scores, and in Iceland girls outscored boys, suggesting that cultural factors can influence this gender difference.

The meaning of this overrepresentation at the high end is anyone's guess. Summers apparently mused that it may explain why there are many more gifted male mathematicians than female. However, aptitude tests are not very good predictors of future educational success. In particular, for reasons that are unclear, the SAT tends to underpredict female and overpredict male academic performance. On average, males score 33 points higher on the math section of the SAT than females who earn the same grades in the same college math courses (www.FairTest.org). Similarly, Chinese nationals tend to do very well on the Graduate Record Examination (GRE) subject tests, although they do not perform much differently in graduate school from their American counterparts, indicating that test score differences do not necessarily translate to meaningful professional distinctions.

In terms of neuroscience, there is evidence that male and female brains differ anatomically in subtle ways, but no one knows how (or even if) these anatomical differences relate to cognitive performance. Women have greater gyrification of the brain surface (and by inference, increased cortical surface area) in frontal and parietal regions[1]. Boys were reported to have an increased gray matter volume relative to girls (even correcting for total cerebral volume), but other authors[2] have contradicted these findings, reporting that this difference in gray matter volume can be accounted for by differences in brain size and is unrelated to gender. A related problem is that studies reporting gender differences in anatomy, no matter how small, are more likely to be published and reported in the press than those that fail to find such differences. And despite these differences, males and females score equally well on IQ tests[3].

One of the clearest cognitive gender differences is in spatial reasoning and navigation, which some media reports have linked to mathematical ability. Spatial cognition is organized differently in male and female rats. In the Morris water maze, female rats rely more on frontal cortex for spatial navigation, whereas male rats rely more on entorhinal cortex. Human males and females use different neural strategies to maneuver through unfamiliar environments as well, with men showing a greater activation of left hippocampus[4]. Men and women also use different behavioral strategies—women are thought to focus on landmarks, whereas men tend to assess the euclidean properties of the environment. Similarly, men outperform women on mental rotation tasks. Some of these differences are linked to hormones—a single testosterone injection improves women's performance on a visuospatial task[5]. Although this difference may well have a biological basis, it seems much too narrow to account for the dramatic overrepresentation of men in science departments at top universities.

Social scientists find that changing a female name to a male name on otherwise identical work increases its perceived value. In addition, female and minority students who are aware of gender and racial stereotypes score lower on tests such as the SAT. In the early years of the SAT, females scored higher on the verbal section, until male test scores were raised by selective inclusion of questions on which males performed better, such as those on politics, business and sports[6]. No similar attempt has been made to 'balance' the math section of the SAT. In light of such evidence that gender bias influences test scores and academic success, it is difficult to take seriously the enshrinement of the test score gap as reflecting biological differences.

In a world of perfectly equal opportunity, what proportion of Harvard's mathematics professors would be female? No one knows, and no studies can be done to find out because humans cannot be examined in a culture-free state. What does seem clear is that we do not live in such a perfect world. In this one, Summers' comments as Harvard's president—and the resulting media hype—are likely to make the road tougher for aspiring female mathematicians and scientists, who now must confront the additional handicap of being told that they are at a biological disadvantage. Putting less faith in aptitude differences and more belief in hard work and individual evaluation of performance seems like a more productive way forward.

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